The Technical Rifleman

Technical Rifleman with Wayne van Zwoll

WAYNE VAN ZWOLL

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Introduction

There are many facets to marksmanship – Wayne van Zwoll is well schooled in each and every one.

A quarter century of writing for some of the finest outdoor publications and turning out a slew of books, few have his knowledge base. Van Zwoll can wax on the finer points of dialing in a scope, calculating the foot-pounds of rifle recoil or even divining the soul of a firearm.

The renown firearms scribe shared some of his more poignant tips and tactics for the application of marksmanship with GunDigest.com readers in 2012. That is what this publication represents – the best and most biting posts from van Zwoll's blog the *Technical Rifleman.*

This compilation was a year in production, but is much vaster. Tapping into van Zwoll's infinite wisdom on hunting and shooting, this publication was truly a lifetime in the making.

Chapter 1

The Evolution of Marksmanship

Wayne fired these 50-yard five-shot groups in rimfire prone competition. Consistent form matters with marksmanship.

One shot does not a marksman make. Neither does it demonstrate accuracy. A single hole, in an animal or a paper target, shows only that you fired the rifle. It takes more to achieve true marksmanship.

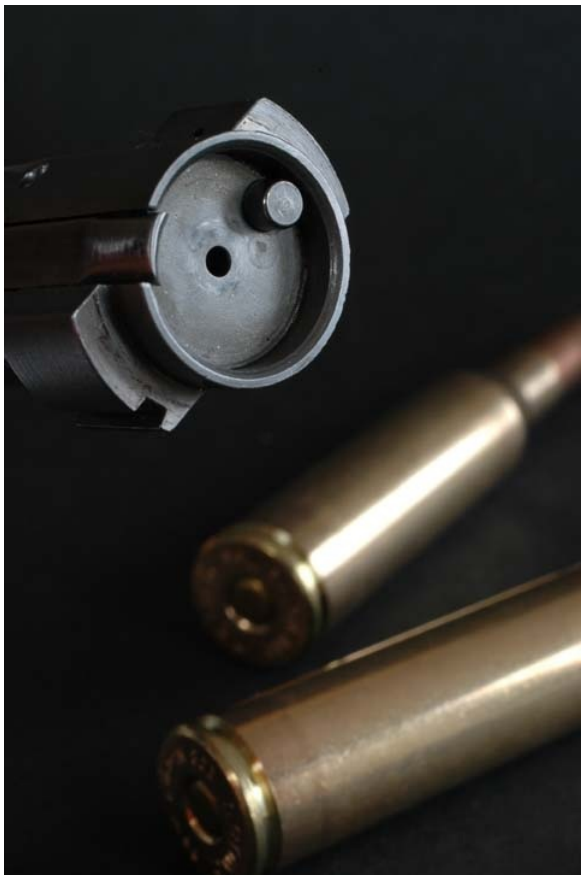
During the iron-sight stage of a smallbore match years ago, I settled into prone and accidentally brushed the trigger. Dismayed, I hardly dared peek into the spotting scope. The best I could hope was that the bullet had missed the

paper, leaving no evidence a shot had been fired. A hole in any of the 10 record targets, or between them, would affect my score.

Squinting into the glass, I was astounded to see a hole in the center of the target I was to shoot. A pinwheel. That shot had nothing to do with my marksmanship or the accuracy of the rifle or ammunition.

In its purest form, accuracy is a measure of consistency.

Standards of accuracy can change over time, as they vary with conditions and shooting gear. Marksmen obsessed with accuracy have developed games and equipment that redefine the term. The first official benchrest match, held in Johnstown, New York in 1947, drew international interest. Special rifles and loads, and better optics, have since enabled shooters to print tiny groups.



Close tolerances in modern rifles and ammunition add up to better accuracy, more consistent hits.

In the UK not long ago, a sharp-eyed shooter drilled a .135-inch five-shot group at 100 yards and a 6.908 group at 1,000 yards under trying conditions. The world's record 1,000-yard group measures inside 2 inches, well under a quarter minute of angle.

Hunting rifles and ammunition have improved a great deal since I started shooting. When you could buy one at retail for $89.50, we considered the 94 Winchester a 3-minute rifle.

Now, with Hornady LeverEvolution ammo, the best .30-30 lever guns punch 1-minute groups. When it appeared, the M-16 rifle couldn't match the accuracy of the M-14 or the Garand. Now, after many refinements, a tuned AR-15 shoots about as well as competitive bolt-actions.

Recently, I fired a Les Baer AR with Federal ammunition launching 77-grain Sierra MatchKings. Sub-minute groups came easily, and one three-shot cluster measured less than half an inch at 200 yards.

In my youth, hunters marveled at rifles that shot into a nickel at 100 yards, but they didn't despair if the groups were bigger. Many marksmen still relied on iron sights, and big game was shot close. These days, interest in tactical rifles, rangefinding devices, high-power scopes and long-range shooting has nudged the accuracy bar ever upward. While smart hunters get as close as possible for shots at game, long-distance hits on paper targets and steel are confidence-builders.

Improved optics and more uniform ammo help make tuned ARs as accurate as most bolt rifles.

Accuracy at distance makes you more successful in competition and afield. When you can hit far away, the close shots seem easier.

To that end, manufacturers of rifles, barrels, scopes and ammunition have poured many thousands of dollars into new products. Darrell Holland (hwww.hollandguns.com), who runs a shooting school in southern Oregon and builds super-accurate rifles, has designed a unique scope reticle for long shots. A series of ballistics cards from Holland help you quickly assess effects of range, wind and shot angle for your favorite load.

In the same way, the fellows at Greybull Precision (greybullprecision.com) manufacture scope dials for specific loads and fit them to Leupold scopes with cleverly designed reticles. I've used Greybull scopes to 780 yards, banging minute-of-angle groups on steel with center holds. A Marlin lever-action printed six first-round hits inside a 10-inch circle from 100 to 600 yards, with center aim. All I did between shots was adjust the Greybull dial for distance. Matching of scope dials to specific bullet arcs has since become a service of most scope-makers.

Ballistics software from Sierra, Nikon and other sources has not only fueled interest in long-range shooting but given riflemen tools to do it. Knowing where to aim or how to adjust the sight at distance is a first step to hitting consistently.

Marksmanship comes next. Holding the rifle still and executing the shot properly is a skill independent of equipment. It is also the pivotal factor in the pursuit of accuracy.

This article originally appeared Aug. 10, 2012 on GunDigest.com.

Chapter 2

Increasing Accuracy Without Taking a Shot

Dry-firing your big game rifle from hunting positions hones shooting fundamentals.

Practice. It's the way to get good at just about anything. Gun drills can even help you get good at doing the wrong thing.

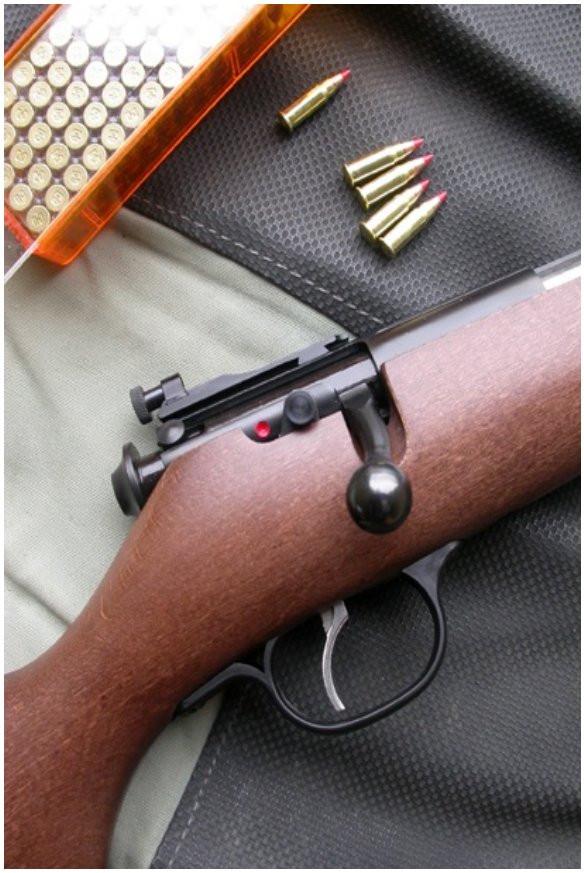
Lones Wigger, the most decorated Olympic rifleman ever, once told me he practiced gun drills up to four hours a day for the U.S. Army Marksmanship Training Unit.

"More importantly, I practiced the right things. Every shot must be well executed. If you're too tired of shooting to shoot well, it's time to quit. A sloppy shot is practice for more sloppy shots," he said.

You've seen people blaze away as if success depended on a high count of empty hulls. AR-15s and autoloading pistols encourage careless shooting –

though they’re not responsible for it.

Another accomplished Olympian, Gary Anderson, dry-fired his .22 rifle so much, he reportedly peened the chamber lip to the point a cartridge wouldn’t enter.



An understudy rifle trains you gently. The .22 rimfire may be the world’s most useful round.

“Launching a bullet is a small part of the shooting routine,” he told me. “Most of the important stuff happens first. Where the bullet goes depends on what you do before it’s free of the rifle, or even out of the case. You can become a very good shooter without hearing a bang.”

Position, breathing and trigger squeeze – even follow-through – can all be done in gun drills as easily with an empty rifle as with live ammunition. You learn to call shots better dry firing because there’s no recoil to disrupt the sight picture when the striker falls. You see clearly errors in shooting form. Action

cycling and recoil recovery beg real shooting; but they’re easier to learn than the foundations of a shot.

Recoil can prevent you from mastering good shooting form. And if you fire only from the bench in your gun drills, you’ll get a false measure of your ability to shoot from unsupported positions. Your finger will become conditioned to make one steady press, when in the field you may have to interrupt the pull as your target suddenly moves, or wind or your pulse bounces the rifle.

Just holding a rifle can help you hit. As a young competitor, I watched television and studied for school exams while strapped into a sitting position with my match rifle. Its weight (13 pounds) stretched and strengthened the muscles and ligaments supporting it.

Reading is another way to improve your shooting without ammo or gun drills. I’ve written several books on rifles, optics and ballistics, hoping some shooters will tire of watching reality television and pick them up.

Other tomes, some of which tutored me in the shooting sports, have a wealth of information little tapped by shooters who spend many times their cost for new guns, optics and ammo. Handloading manuals from Nosler, Hornady, Barnes and Speer, Vihtavouri, Hodgdon and the like give you reams of data and juicy information on bullet travel. Use ‘em.

Gifted shooter Annie Oakley built her reputation with .22 rifles. She shot often, but not from a bench.

If you depend on gun drills alone to perfect your marksmanship, you'll likely be disappointed. No rifleman who must earn a living doing something else can spend enough trigger time learning that way. Even if you lean on an understudy .22 rifle to reduce ammo cost and shoot where centerfires talk too loud or reach too far, you're still constrained.

Jack O'Connor wrote of dry-firing every day at a black brick on his neighbor's chimney. For iron sights, I've used a black thumbtack on the living room wall.

Dry firing and reading about rifles can make you an expert without making you flinch during a gun drill. The bang is truly an afterthought.

This article originally appeared Sept. 14, 2012 on GunDigest.com.

Chapter 3

Keeping On Target With Bipods, Tripods

Attached bipods, like this Harris, work best prone; some have extendable legs that work for sitting, too.

The animals you hunt live amid an abundance of rocks, trees, hillocks and other rifle rests. Alas, there's never a rock or a limb where you need it, when you have little time to fire.

That's why Cro-Magnon man invented a rest for his spear…Well, perhaps the bipod doesn't go that far back. But it's been in use a long time. Crossed sticks helped sharpshooters hit at distance before the advent of smokeless powder. Commercial hunters who swept the plains clean of bison used them to deadly effect. By the middle 1880s, the toll was so great that human scavengers would glean three million tons of bones from the prairie.

Military as well as sporting rifles are commonly available with bipods attached. Widely hailed, the Harris bipod has been improved over the years with the addition of extendable legs. New versions also incorporate some latitude for tilt, so you can rotate the rifle slightly to square it up on sloping ground. That's a useful feature, even if the device has adjustable legs. There may be no time to extend or retract a leg – or you can't risk doing so for fear of drawing attention. If there's a bit of "rock" to the bipod base, you can twist the rifle enough to get it reasonably level from the shoulder.

Most bipods for sporting rifles snap into the front QD swivel stud. Some rifles intended for bipod use have two studs, so you can attach a sling to the other. A bipod should be mounted so when flipped to a "carry" position, the legs point forward.

Even with a tripod, add bracing offhand. This rifleman has employed a tripod under his trigger arm.

Setting a bipod for a shot, choose a firm but impressionable surface over a hard one. As you pad your rifle on a bench rest, you'll get better results with

bipod legs on soft ground or a jacket, which absorb vibration caused by your pulse and by the shock of firing and bullet travel down the bore. Vibration kicks bullets off course.

At a recent shooting event, I managed consistent hits on pie-plate targets at 500 yards with a Ruger .30-06. The rifle, and Hornady's M1 Garand load, was partly responsible, as was the Zeiss scope.

But the Harris bipod surely helped. I was careful to plant the legs in gravel, not on nearby concrete or wood. The soft substrate acted like sandbags to suck high-frequency bounce from the rifle.

While long-legged bipods can be used from the sitting position, most are designed for prone shooting. I keep the legs as low as I can to shoot comfortably. A bipod shouldn't put you in an uncomfortable position. If it forces your head up, or puts an acute angle in your elbows, it's too high.

You're smart, after planting bipod feet, to push into the rifle with your shoulder. Pressure on the bipod legs should seat them more firmly. Some lightweight bipods yield to that pressure. They're not on my Christmas list.

To assist a bipod, make your left hand into a fist and place it under the stock's toe, squeezing or relaxing your hand to make slight elevation changes. Another tip: buy or fashion a small sandbag – no larger than a baseball, but brick-shaped, with lightweight filler – to hold under the stock toe. It's a boon if you must bring the stock a little higher than your fist alone can boost it comfortably.

A rifle tripod trumps a bipod, offhand. Grasp the "neck," finger and thumb alongside the rifle. Lean forward.

The long-legged version of the attached bipod is a pair of shooting sticks. Standard kit for every professional hunter in Africa's long grass, shooting sticks can be as simple as shaved tree limbs bound by strips of inner tube. More sophisticated versions, with telescoping, quick-locking legs, have proliferated.

Stoney Point has some excellent sticks. I especially like those by Bog Pod, which offer pop-off heads to accommodate rifles, cameras, even binoculars. There's a squeeze-grip to bring your hardware on target and lock it there with one hand.

As this is written, I'm bound shortly for Africa with a pair of Bog Pod tripods, which offer more stability than bipods and can be – perhaps counter-intuitively – faster to use. The extra leg adds little heft.

If using a bipod offhand or kneeling, keep the legs a bit longer than you think you'll need. Swing them well forward when you plant them, so they lean toward you. Grasp the juncture, your fingers and thumb up alongside the rifle to

steady it. Lean forward into the sticks. You'll secure the feet in the ground while letting the legs carry your body weight.

This article originally appeared Sept. 6, 2012 on GunDigest.com.

Chapter 4

Bullet Ballistics 101

Pressure, Velocity & Distance

With 55,000 psi under your eye, stout lockup, flawless steel and perfect headspace matter.

Bullet Ballistics: Pressure

When a primer spits fire into the powder charge and burning commences, gases form, increasing pressure inside the case and (because pressure produces heat), accelerating the burn. On a bullet ballistics graph, you'll see a pressure peak after a short horizontal line showing the delay between primer detonation and powder ignition.

After that peak, which typically happens within a millisecond (1/1,000 second) after the powder starts to burn, the pressure curve arcs back down. This

decline is relatively gradual as the bullet moves forward, increasing the bore volume behind it. The faster the powder, the steeper the curve on both sides. The area under this pressure/time curve translates to bullet velocity. Two to three milliseconds after the striker hits the primer, pressure has dropped to zero. The bullet is on its way.

A 180-grain bullet from a .300 Weatherby Magnum exits the muzzle of a 26-inch barrel about 1 1/4 milliseconds after it starts to move. The following bullet ballistics chart shows what happens (data adapted from a pressure/time curve in the excellent text *Any Shot You Want*, a loading manual by Art Alphin's A-Square company).

Bullet Ballistics Chart

Time (seconds)	Pressure (psi)	Velocity (fps)	Distance (inches)
0	0	0	0
.0001	12,000	60	.02
.0003	36,000	500	.60
.0005	60,000 (near peak)	1,400	2.80
.0007	42,000	2,350	7.40
.0009	24,000	2,970	13.80
.0011	6,000	3,250	21.30
.0013	100	3,300	26.00

Bullet Ballistics: Peak Pressure

A few things to note. First, peak pressure comes when the bullet has moved only about 3 inches, even with the slow-burning fuels appropriate for a .300 magnum.

Then, pressure drops off fast, too, losing 90 percent of its vigor in the next 18 inches of barrel. But the bullet continues to accelerate even as pressure behind it diminishes. Between 14 and 21 inches, pressure loss totals 18,000 psi. But bullet speed increases 300 fps!

Finally, with very little pressure remaining at the muzzle, the bullet is still accelerating! The value of a long barrel is clear, even if nearly all of it is used to control the tail of the pressure/time curve.

Surgeon rifles start as solid steel billets. Receivers easily endure 60,000-psi – and more.

Bullet Ballistics: Pressure/Distance & Pressure/Time

A pressure/distance curve differs from a pressure/time curve in slope, but it has the same general shape: steeper at the start than at the finish. The area under a pressure/distance curve represents the energy available for the bullet. However, the energy generated is not all available downrange. A lot of it is lost in thermal (heat) transmission, expansion of the case into the chamber wall, bullet/rifling friction and bullet rotation.

Plotting a load's pressure/distance curve helps designers of gas-driven autoloading rifles because these rifles must tap the gas at some point in the bullet's travel. Too much pressure, and the slamming can damage rifle parts. Too little, and bolt travel is insufficient to clear the fired case.

Bullet Ballistics: Velocity

Measuring gas pressure proved as difficult at first as measuring bullet velocity. Then, in the mid-1800s, Alfred Nobel and an American named Rodman came up with solutions to that problem at the same time. Rodman's, the crusher system, is still in use.

It’s a factory procedure not easily or safely performed in a home shop. A small cylindrical piston is slid into a hole in the barrel of a test gun, and a copper or lead pellet is inserted snugly between the top of the piston and a stationary anvil. When the rifle is fired, the piston pushes against the pellet or crusher, shortening it.

The difference in crusher length before and after firing is then converted mathematically to a pressure range, in units of CUP or LUP (copper units of pressure or lead units of pressure).

Copper crushers are generally either .146 in diameter and .400 long to start with, or .225 in diameter and .500 long. Choice depends on application. Copper crushers work best in centerfire rifles and handguns that generate substantial pressures. Lead crushers (.325 x .500) typically register the low-pressure loads in rimfire guns and shotguns (though small-diameter copper crushers can be used too). Crushers are calibrated in a test press.

Pounded by high pressures, crushers don’t register peak pressure accurately because the flow of copper is slower than the change of pressure in the chamber. Also, the moving piston must be brought to a halt, which skews a reading in the opposite direction.

Thin barrel walls and lightweight receivers make lively shotguns. Pressures are modest.

Bullet Ballistics: CUP

Copper units of pressure (CUP) and lead units of pressure are not the same; nor can they be interchanged with another common unit of pressure, pounds per square inch (PSI).

A CUP value may coincide with a PSI value; for example, SAAMI lists 28,000 as maximum average pressure for the .45-70. Both CUP and PSI units apply. But maximum average pressure for the .243 is 52,000 CUP and 60,000 PSI. Most cartridges show similar discrepancies. Sadly, there's no easy way to convert CUP to PSI or vice versa.

A modern device for pressure measurement in firearms is the piezoelectric gauge. It registers an electric charge delivered through a transducer when a crystal is crushed. Pressure applied to the crystal yields a proportional transducer reading in pounds per square inch.

Conformal transducers are installed in the barrel, just like crusher pistons, and become part of the barrel. External transducers can be mounted on the barrel, then removed for replacement or calibration checks.

Another pressure tester that’s become popular among shooters is the strain gauge. Developed for consumers by chronograph guru Ken Oehler, it’s essentially a length of wire you glue to the outside of the chamber wall. When you fire, the chamber expands and the wire stretches. That stretch translates into pressure. It does not equate with readings from a crusher or a piezoelectric gauge.

This article originally appeared Sept. 14, 2012 on GunDigest.com.

Chapter 5

Straight Shooting On Bullet Trajectory

Long, heavy, sleek bullets at 2,950 fps make the .338 Lapua the choice of many long-range snipers.

Bullets travel in arcs. You knew that. Actually, they're parabolic arcs. A bullet drops faster as it goes farther.

Well, not really. Gravity determines how fast a bullet drops, and its force doesn't change over the course of a bullet's flight. But the arc does get steeper at distance. Why?

Gravity's Effect on Bullet Trajectory

Consider the bullet not as a rocket but as a fragment driven by an explosion. This spinning shard exiting the muzzle at, say, 3,000 feet per second (fps) hurtles headlong into a dam of air that resists penetration. When you swim, you feel

resistance. It’s more palpable when you cannonball off the high-dive or take a spill behind the ski-boat.

Air isn’t as thick as water, but you’ll feel it when you reach outside an automobile window. At 60 miles per hour, that car is traveling 88 fps. A bullet at 3,000 fps is moving 34 times as fast. The headwind it meets is 34 times stronger than what you feel against your hand at highway speed.

Because a bullet has no rocket, it begins to decelerate as soon as the powder’s thrust loses out to air resistance on its nose and air friction on its sides. At the same time, gravity starts hauling the bullet to earth. Clearing the muzzle, that bullet starts to drop immediately, at an accelerating rate of 32.16 feet per second. But few bullets stay aloft for a full second.

A 7mm magnum bullet started at 3,150 fps reaches a deer 250 yards off in a quarter-second; given deceleration that brings average velocity to 3,000 fps. During that quarter-second, the bullet drops three feet (not eight feet, as gravity pulls it faster and farther the last quarter-second than the first).

Target knobs calibrated to specific bullet trajectories let you “click” to known distance and hold center.

If your line of sight were parallel to line of bore, the bullet would strike three feet low. A slower bullet drops the same distance in the same interval. It just doesn't go as far. Say your .308 bullet clocks an average 2,400 fps over its first 200 yards. Instead of landing three feet low at 250 yards, it prints three feet low at 200.

The slower a bullet goes the less ground it covers per unit of time. Because a bullet decelerates, it gives gravity more time per unit of distance at the far end of its arc. That's why the arc is steeper there. If you dropped a bullet from your fingers next to a rifle just as a bullet was fired horizontally from that rifle, the two bullets would come to earth at very nearly the same time.

Seeing a bullet's arc is a distinct advantage in learning about trajectory. That's why machine guns and anti-aircraft cannons are fed tracer bullets. Drift and deceleration show up in tracer paths. Air gunners trained during World War II were often started with BB guns that made trajectory visible.

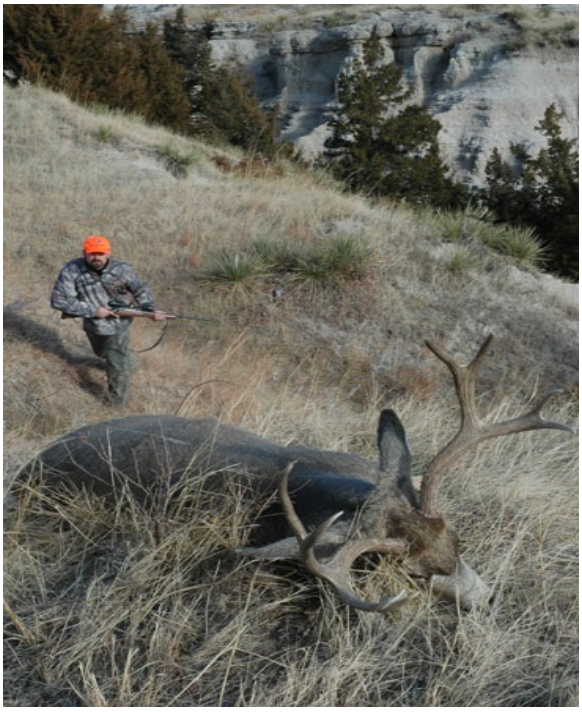
Distance's Effect on Bullet Trajectory

Distance lays a heavy hand on bullets. A .30-06 zeroed at 200 with 180-grain Partitions at 2,700 fps puts them 50 inches low at 500 yards, 400 inches low at 1,000 (double the range, but eight times the drop).

A .300 Winchester launching the same bullet at 2,960 gives up 43 inches at 500 and 352 at 1,000. While speed flattens arc, the rate of deceleration matters, too. A heavy bullet started slower than a lightweight bullet of the same shape and diameter drops more steeply at modest ranges. Farther out, a heavy bullet can actually pass its lighter counterpart. Its momentum is greater. It has a higher ballistic coefficient and a lower rate of deceleration. So drop at very long range is less with the heavy bullet.

Many shooters have been bamboozled into thinking a bullet rises above line of bore during flight. Nope. The misunderstanding results from trajectory illustrations that aren't carefully drawn. Sight-line is not parallel to bore-line, but at a slight converging angle. Sight-line dips below bore-line and the bullet's arc.

Sight-line never meets bore-line again, as both are straight. They cross once and forever diverge. A bullet travels above sight-line at midrange because the sight-line tilts down through the trajectory. Later, the bullet drops below sight-line.



Shooting at game, closer is always better. But long-range practice makes all shots afield easier.

Temperature's Effect on Bullet Trajectory

Temperature affects trajectory. Warm air is thinner than cold, so your bullet meets less resistance on a warm day, just as an airplane gets less lift on a warm day. But the effect of extreme heat or cold on bullet placement has little to do with the influence of air temperature on flight. Figure no more than half a minute of elevation for every 100-degree change in temperature.

A bigger change caused by temperature results from its influence on breech pressure. Pre-heated powder generates higher pressure. A chilly day can make the cartridge perform sluggishly. Tests run by Art Alphin (A-Square) with a .30-06 showed that at 40 degrees a charge of 51 grains RL-15 generated 54,600 psi to push 180-grain Nosler Ballistic Tips at 2,675 fps.

That rifle and load registered 59,900 psi and 2,739 fps with the air temperature at 120 degrees. Cartridges left on a hot dashboard in a safari vehicle can get much warmer than the rifle and cause higher pressures than the thermometer suggests. Rule of thumb: three fps for every degree of temperature change.

Altitude's Effect on Bullets

Altitude also influences bullet flight. The higher you go, the thinner the air and the less resistance it offers. But as you climb to thinner air, temperatures usually drop. So elevation and temperature changes can cancel each other. In the mountains, air resistance can be greater because of the cold and less because of the elevation.

This article originally appeared April 4, 2012 on GunDigest.com.

Chapter 6

The Science of Recoil

When your body is firmly anchored, in prone or at the bench, it can't yield to recoil.

Launching a bullet sends a surge of energy in the opposite direction. We feel it as recoil. Boost bullet speed or weight, and recoil increases. Adding weight to a rifle reduces felt recoil because the mass absorbs the thrust. But shooting position also affects what you feel. If your body is free to "give" under recoil, it will hurt less. Stock dimensions matter too. A low, sharp comb can bang you mercilessly. A short length of pull gives the rifle a running start. A grip and forend that afford your hands little purchase let the rifle come back fast. A small, hard buttplate focuses and accentuates the thrust.

Offhand isn't a steady position, but your body can flex with recoil, so it hurts less.

Uncomfortable recoil makes you flinch. Flinching makes you miss. No matter how big and tough you are, lively recoil gets your attention. If you're thinking about recoil or anticipating the rifle's kick, how can you focus on smooth execution of a shot? You can't.

Muzzle brakes mitigate recoil by bleeding gas through ports to the side as the bullet exits. But the noise and blast of a braked rifle can affect you as severely as the recoil. Without adequate ear protection, you'll sacrifice your hearing to muzzle brakes. At the range, ear-plugs and muffs (I use both) make brakes practical. In the field, you'll want to pick up slight noises. Solution: install a brake for routine practice, then replace it with a cap to cover the muzzle threads when you hunt. You'll probably not notice recoil when firing one shot at game.

Because felt recoil varies from rifle to rifle, and load to load, ranking cartridges by recoil energy is pointless. But you can easily determine the recoil

thrust of your pet loads in your rifle:

KE=MV2/GC, where M is the rifle's mass and V is its velocity. GC is a gravitational constant for earth: 64.32. V= bullet weight (grs.)/7000 x bullet velocity (fps) + powder weight (grs.)/7000 x gas velocity (fps)/M.

Powder and gas figure in because as "ejecta" they contribute to recoil. Gas speed varies, but Art Alphin, in his A-Square loading manual, suggests 5200 fps as an average. The "7000" denominators convert grains to pounds so units make sense in the end.

Like high velocity, big bullets boost kick. From left: .450-400, .470 N.E., .500 N.E.

For a 180-grain bullet fired with a 70-grain powder charge at 3000 fps from an 8 ½-pound .300 Magnum, the numbers line up like this:

180/7000 x 3000 + 70/7000 x 5200 = 8.5 x V. Simplified: (77.143 + 52)/8.5 = V = 15.19 fps.

The final formula: 8.5(15.19)2/64.32 = 30.49 ft.-lbs. of recoil.

If math either bores you or triggers high-school nightmares, you can scrounge recoil figures from tables, available from a variety of sources for common rifles and cartridges.

Some loads are unconscionably brutal. The .378 Weatherby hammers you with 90 ft.-lbs. that feel like a whack from a splitting maul. Lightweight rifles can be vicious, even with proper stocking. My 7 ½-pound .458 leaves cheek and clavicle begging for mercy. A 9-pound .30-06 delivers a civil 19 ft.-lbs. of recoil with a 180-grain bullet. A 7-pound ’06 hits you with 25 – about as much as a 150-grain load in a 9-pound .300 Winchester.

To shoot well, use a rifle that doesn’t beat you up. There’s no glory in fighting recoil, or missing because you flinch.

This article originally appeared March 21, 2012 on GunDigest.com.

Chapter 7

Headspace 101

What Happens Inside Your Rifle's Chamber

Headspace gauges for the belted .375/338 are sized for bolt-to-belt measure. Wear of the chambering reamer (right) can diminish the size of chambers over time, affecting headspace.

Headspace is one of the most critical measures in your rifle. A quick definition: the distance from the face of the locked bolt to a datum line or shoulder in the chamber that arrests the forward movement of the cartridge. The term originated when all cartridges had protruding rims, so the measure was initially taken only at the head. Now it includes other spans.

Headspace is measured from the bolt-face to the mouth of a straight rimless hull like the .45 ACP, whose mouth stops against a small, abrupt shoulder at the front of the chamber. In a belted magnum, the stop is the leading edge of the belt, in the back of the chamber. On a .30-30 case it's the front of the rim. The datum line for rimless or rebated bottleneck rounds like the .270 and .284 lies on the shoulder. Semi-rimmed cartridges theoretically headspace on the rim, but sometimes (as with the .38 Super Automatic) the rim protrusion is insufficient for sure function. The case mouth then serves as a secondary stop. The semi-rimmed .220 Swift has a more substantial lip; but most handloaders prefer to neck-size the Swift, so after a first firing, the case actually headspaces on its shoulder.

If there's too little headspace, the bolt won't close on a chambered round. Too much headspace can shorten case life, even cause case ruptures and dangerous gas escape.

The Reising submachine gun uses the .45 ACP cartridge, which headspaces on the mouth.

When you pull the trigger, many events follow. The blow to the primer crushes shock-sensitive priming mix, which detonates. The explosion shoots flame through the flash-hole in the primer pocket, igniting the gunpowder. The resulting gas expands rapidly, stretching the ductile brass case. The thin case wall up front is ironed against the chamber wall, but the solid rear section around the primer pocket stays close to its original diameter, slightly smaller than the chamber. Gas pressure shoves it back against the bolt face. Still expanding, the gas thrusts the bullet out of the case.

Because cartridges vary slightly in dimensions, and each must chamber easily, the chamber must be a tad bigger than the average case. If there's too much distance between the bolt face and the point in the chamber that stops the forward motion of a cartridge, however, you have excess headspace.

Until the thick case head moves rearward to meet the bolt face, the bolt face isn't supporting it. The striker has pushed the case to its forward stop. Excess headspace causes excessive stretching. After repeated firings, the "work hardened" case becomes brittle as well as thinner just ahead of the web. It no longer stretches easily and can crack at the web, or even separate.

A cracked case is dangerous because it spills powder gas into the chamber. That gas jets through the tiniest corridors at velocities that can exceed bullet speed. It may scoot along the bolt race, through the striker hole, into the magazine well. It can find your eye faster than you can blink.

Gunsmiths measure headspace with "go" and "no go" gauges. The "go" gauge is typically .004 to .006 shorter than the "no go" gauge for rimless and belted cartridges. The bolt should close on a "go" gauge but not on a "no go" gauge. Theoretically, if the bolt closes on a "no go" gauge, the barrel should be set back a thread and rechambered to achieve proper headspace. However, many chambers that accept "no go" gauges are still safe to shoot. The "field" gauge, seldom seen now, has been used to check these (mostly military) chambers. It's roughly .002 longer than a "no go" gauge.

Big-bore rounds are belted (.375, left), rimless (.416 Rigby) or rimmed (.470 and .500 NE, right). The belted and rimless were meant for magazine rifles. Rimmed rounds work best in hinged-breech doubles.

Minimum and maximum headspace measurements are not the same as corresponding minimum and maximum case dimensions. For example, a .30-06 chamber should measure between 1.940 and 1.946, bolt face to shoulder datum line. A .30-06 cartridge usually falls between 1.934 and 1.940. Case gauges perform the same check on cartridges that headspace gauges do in chambers.

An obvious difference: case gauges are female and don't indicate headspace. They simply show whether a cartridge will chamber in a rifle that's correctly barreled. Headspace is a steel-to-steel measure. Altering case dimensions changes the relationship of the cartridge to the chamber. Reducing head-to-datum line length of the round can result in a *condition* of excess headspace, even if the firearm checks out perfectly.

This article originally appeared July 23, 2012 on GunDigest.com.

Chapter 8

Thinking Inside the Boxlock

This best-quality sidelock by Holland & Holland boasts finely-engraved plates. The sidelock is still considered the most elegant of double-rifle mechanisms.

About the time George Armstrong Custer made ready to round up wayward Sioux on the flanks of the Little Bighorn, a couple of gunmakers working at Westley Richards of Birmingham, England fashioned a new rifle mechanism.

Like the dropping-block rifle John Moses Browning would build just a few years later (marketed by Winchester as its Model 1885), the hinged-breech action of William Anson and John Deeley was stout and reliable. It housed the sears, hammers and hammer springs of a double-barrel rifle or shotgun in a compact frame without sideplates. It would come to be called a boxlock. And it shifted the tectonic plates of British gunmaking.

Earlier doubles held the firing mechanism on plates that extended behind the hammers, the first of which were external. On a back-action sidelock, the springs lay behind the hammers; bar-action sidelocks carried the springs in front. Makers had to choose between removing wood from the grip or from the standing breech.

A modern boxlock, this well-built Heym double is chambered in .470 Nitro Express.

In both cases, they introduced some weakness to that part of the firearm. The Anson & Deeley boxlock not only retained more material in this critical section, it made internal hammers practical. While sidelocks remained (and are still) popular, the boxlock was quickly adopted around the world. It was much less expensive to produce in quantity and easily adapted to cartridges of any size.

These days, sidelocks deliver a generous canvas for engravers. They also invite the hand of uncommonly gifted craftsmen; hand-detachable sidelocks are a hallmark of fine gunmaking. But best-quality boxlocks now command utmost respect, and prices rivaling those of sidelocks. A boxlock double rifle from a maker with deep British roots can cost more than a sports car.

I used one recently to hunt Australian buffalo. A Webley and Scott chambered in .500 Nitro Express, it dated to 1910. But despite a century of service in the bush, and the terrific pounding delivered by those cartridges (570-grain bullets at 2100 fps) the rifle was still tight. It opened and closed sure and silent as a hydraulic press. Quite a tribute to William Anson and John Deeley.

This boxlock sold for much less than sidelocks of its day. Now both are costly.

Double rifles have long been favored by hunters of dangerous game, for several reasons. First, they have two separate firing mechanisms. If one (or a cartridge) fails, the other is instantly available.

Secondly, there's no feeding mechanism to jam, and doubles can be reloaded quickly. Also, the double rifle has no receiver, so overall length is a hand's breadth shorter than that of magazine rifles with same-length barrels. The shallow profile of a double, and its low iron sights, put your sight-line tight to the barrel and nearly as snug to your forward hand. Fast, natural pointing results – assisted by low-between-the-hands balance.

The mediocre accuracy of double rifles matters not to their many fans. A double is meant for close, urgent shooting with iron sights. Minute-of angle groups are irrelevant. Alas, getting right and left barrels regulated to plant bullets to the sights can try the patience of a friar, and is as much art as science. It's also a reason few loads exist for rimmed, big-bore "Express" cartridges. Rifles regulated for one load seldom shoot accurately if either bullet weight or speed is changed.

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Chapter 9

Get the Right Scope for the Right Rifle

The 2 3/4x Redfield on this M70 is Wayne's idea of a fine all-around big game sight. Note low mount.

A lever-action carbine is as lithe under a scope as a sports car under a roof rack. On a double rifle, optics make no sense at all. While my aging eyes need glass for sharp aim, not all rifles need glass to be useful. Many animals are shot very close to the muzzle.

In Africa, firing at dangerous game farther than you can toss a stone is bad form. In typical whitetail cover, and probing the lodgepoles in elk country, you shouldn't need a scope.

Still, a low-power scope properly mounted is as fast as irons. Actually, it's faster, because reticle and target appear in the same focal plane.

Your eye sees both in sharp detail. And modest magnification helps when you must thread a bullet between branches. Up to 3x or even 4x, magnification won't slow a practiced shooter. Field of view shrinks as you boost power – but a rifle sight is not a picture window.

The first scopes for big game were tidy, though steel tubes made them relatively heavy. Hunting rifles in those days weighed 7 ½ to 8 ½ pounds without a scope, so the extra heft (12 to 18 ounces for a 4x or 6x steel sight) remained a modest proportion of finished weight.

Also, objective diameters of less than 40mm kept bulk to a minimum while permitting use of low rings.

Surely, there were big scopes back then, from Lyman's limousine-length Super TargetSpot to the enormous Unertl, with a recoil spring the diameter of a rolling pin. But these fine and costly sights made sense only on heavy-barreled rifles with thick walnut stocks – rifles for dusting distant woodchucks with the likes of the 2R Lovell and .219 Donaldson Wasp.

A 2-8x, this Zeiss Duralyt has great versatility. Its 42mm objective admits all the light you can use.

Besides jacking a rifle's center of gravity up from between your hands, a heavy, bulky scope in high rings pulls your cheek from the stock. Losing comb contact, you compromise rifle support and leave your head bobbing about in space.

The problem is especially acute when you affix a big scope to a rifle designed for iron-sight use. This arrangement turns the comb into a baton that swats your chops on recoil.

Stocks on early rifles fitted with iron sights suited scopes like the popular 2 1/2x Lyman Alaskan and 4x Noske, whose 7/8-inch tubes and straight front ends permitted very low mounting.

Such slender tubes have now gone the way of bias-ply tires, but 1-inch scopes with tube-diameter objectives have hung on. Some of these are fixed-power models, like the Weaver K2.5. Many are variables, commonly 1-4x or

1.5-5x, like the Leupold VX3 on my Montana .375. All have much better optics than their steel forebears.

Many shooters think compact sights can't offer bright images. Wrong. Image quality – sharpness as well as brightness – depends mainly on the lenses and their coatings. In normal light, your eye's pupil contracts.

If a scope's exit pupil (objective diameter / magnification) is larger than your eye's pupil, you can't use all the light coming through the sight. Only in dim conditions does big front glass help at all.

For most big game hunting I favor 4x magnification. The 32-to 40mm objectives common to the 4x provide 8 to 10mm of exit pupil – more than your eye can use even in total darkness. A 6×36 scope delivers a shaft of light big enough for any shooting conditions.

Want more power? Well, probably you don't, at least for deer and elk. If you're shooting small animals at distance, you may benefit from higher magnification. But you needn't endure scopes with maws the size of motorcycle mufflers. A 3mm exit pupil suffices for Dogtown – as in a 14x scope with a 42mm objective.

For big game, the long-popular 3-9×40 is still a top choice. And as competition in this slot is brisk indeed, you'll find bargains at every price point. My latest rifle, a .25-06 by talented gunmaker Patrick Holehan, wears a 3-10×42 Swarovski, about as big a scope as seems appropriate. I'd have been as pleased with a 3-9×36, or Leupold's 2.5-8×36.

The Weaver 6×38 on Wayne's Ruger No. 1is bright and lightweight, with plenty of field – and power.

Another concern when choosing a scope is free tube – space available for rings. In days of yore this was no issue at all, because scopes were of fixed magnification and had tubes as long as a swimsuit model's legs.

Now scopes are short-coupled, with big turrets and power-selector rings that take up lots of tube. You're wise to consider where the scope must sit on the rifle to give you proper eye relief.

Some scopes now are AR-specific, following the market to rifles with a mean look and no soul. The high line of sight mandated by the high comb of ARs, and the full-length Picatinny rail standard on models intended for scope use give you more options that do bolt-or lever-action rifles. Rails give even short-coupled scopes plenty of latitude fore and aft.

Leupold catalogs several sights specifically for the AR, from the CQ/T 1-3×14 scope to a 1×14 Prismatic sight to the new DeltaPoint reflex red-dot sight with magnesium housing. I have a Mark AR 3-9×40 on an AR in 6.8 SPC.

No, I’m not categorically opposed to big scopes. Or to liberal politicians or people who drive 55 in the left-hand lane. But sights should not over-burden rifles. And if your rifle’s sight accounts for more than 15 percent of its overall weight, you might ask yourself: Do I really need all that glass?

This article originally appeared April 18, 2012 on GunDigest.com.

Chapter 10

Scoping Out MOA, Milliradian

Minute of Angle and Milliradian (Mil)

Most scope dials have 1/4-minute "clicks." Now popular: graduations to match bullet arcs to distance.

Though shooters carry the terms as common coin, not everyone can define "minute of angle" and "mil" (milliradian).

Minute of Angle

A minute of angle, usually used as a measure of group size or shot dispersion, spans 1.047 inch at 100 yards. Call it an inch. But as it is an angular measurement, its value increases with distance.

At 200 yards, that 1-minute group spans 2.094 inches. OK, round it to 2.

At 50 yards, a 2-inch group is 4 minutes big. You can get away with approximations out to half a mile or so.

At 1,000 yards, a minute of angle is not 10 inches but about 10 1/2.

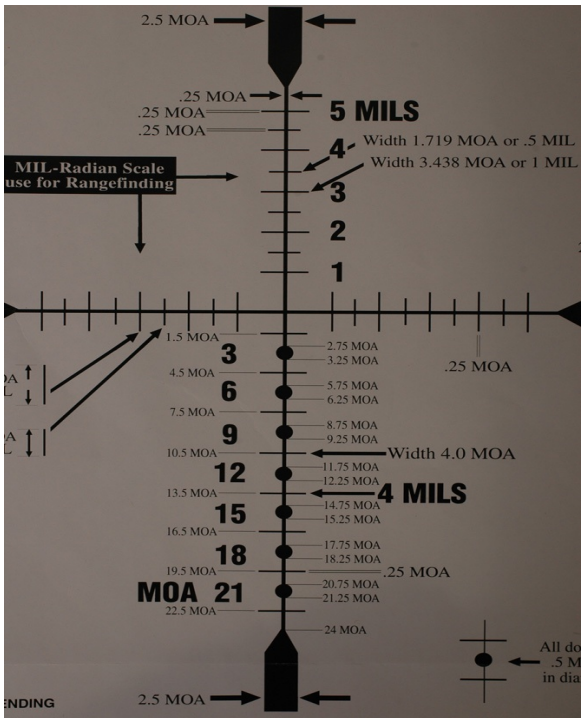
The derivation is thus: A circle of 100 yards radius has 360 degrees of roughly 60 inches per degree on its perimeter (total: 21,600 minutes).

While a hunting rifle that prints into 2 inches at 100 yards will keep all its bullets in deer vitals to 400 or beyond, most shooters these days want better. Some rifles are guaranteed to drill minute-of-angle groups; a few have a half-minute standard.

That's very hard to ensure, even with the best of ammunition. Mainly that's because ordinary shooters with very accurate rifles still punch ordinary groups. Benchrest competitors commonly shoot "in the twos," meaning 2 to 3 tenths of an inch, or a quarter minute of angle.

Milliradians (Mils)

The mil dot reticle gets a lot of attention these days. "Mil" has nothing to do with "military." It is an abbreviation for milliradian, 1/6400 of a degree in angular measure. That's 3.6 inches at 100 yards, or 3 feet at 1,000 yards.



Taken from an actual reticle, this diagram shows both mil dot and minute-of-angle graduations. (Click the image for a larger view.)

In a scope reticle, a mil is the space between (typically) 3/4-minute dots strung on a crosswire. To use this reticle as a rangefinder, you divide target height in mils at 100 yards by the number of vertical spaces subtending it. The result is range in hundreds of yards.

Example: A deer standing 3 feet at the shoulder (10 mils at 100 yards) appears in your scope to stand two dots high. Divide 2 into 10, and you come up with 5; the deer is 500 yards away.

You can also divide target size in yards (1, in this case) by the number of mils subtended (2) and multiply by 1,000 to get range in yards.

A mil dot reticle must be calibrated for a single magnification in a scope. For variable scopes, that's typically the top magnification; some high-power sights are calibrated at other settings.

With a little practice, mil dots become easy to use. A mil dot reticle gives you a rangefinder and a way to compensate for holdover and wind drift, all in

one image. For short shots, you can ignore the dots and use the reticle as a crosswire.

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Chapter 11

Tips for Custom Rifle Scopes

In black and gold, Leupold's VX-R enhances this O'Connor Tribute Rifle. CS offers other finishes, too.

Custom rifles have served American shooters since flintlocks were fashioned on home forges. Then each rifle differed from the next.

For the most part, rifle-scopes have been mass-produced. While scopes appeared on rifles more than 150 years ago and were even used by Civil War snipers, they didn't take the hunting field by storm.

That's partly because they were expensive. In 1926, well after smokeless cartridges like the .30-06 and .270 were sending bullets on flat arcs at over 3,000 fps, a Zeiss 4x Zeilvier cost $45. By pre-Depression standards, that was an enormous sum. Even twenty years later, as scopes inched up in price, you could still buy a Fox Sterlingworth shotgun for $65, a Winchester Model 21 shotgun for $111. A Parker skeet gun would set you back $184.

In 1926, you could buy a good house for a four-figure sum. Automobiles cost hundreds of dollars, not tens of thousands.

Then there was the reliability issue. Scopes fogged. Reticles of fine spider web broke. Windage and elevation adjustments were crude and didn't always move point of impact as expected. Even when a scope functioned as intended, it was plagued by optical limitations of the day. Uncoated lenses lost up to 4 percent of incident light at each surface, producing dim images at dawn and dusk. Eye relief was critical and discouraged shooters who'd teethed on iron sights. Moving the adjustments moved the reticle in the field of view, so after zeroing, the reticle often appeared off-center. Sometimes it was far off center. Rain and snow not only distorted the sight picture by accumulating on outside glass but moisture could leak into the scope.

During the 1950s and 1960s, you could buy very good scopes at very reasonable prices. Coated lenses brightened images. Nitrogen injection prevented fogging. Mechanical advances brought the constantly centered reticle. Scopes became lighter in weight when alloy tubes replaced steel. Adjustments were refined to yield reliable quarter-minute adjustments. In that era, the switch from iron sights to scopes on hunting rifles gathered steam. Within another decade, barrels would appear without iron sights. Since then, as hunters came to consider scopes necessary on all but double guns for big African beasts, scopes have vaulted in price and sophistication.

The VX-R here is among Wayne's favorite Leupold variables. It's available in Scout form from the CS.

There are now so many scope makers and models that you could ask: Why on earth does Leupold offer a custom shop? What could you want that's not already on the market, sometimes replicated many times over? I asked Alan Ransom, who runs the CS at Leupold's Beaverton, Oregon headquarters.

"For one thing, you can get a scope that's no longer made," grinned Alan. He knew I had draped myself in sackcloth and mourned many days when Leupold discontinued its M8 3x, one of the sleekest and most useful scopes for big game rifles ever made. "Our CS 3x isn't exactly like the older model. It's better, optically, and there are slight cosmetic changes…."

I interrupted him to order one.

Another CS service is the installation of custom reticles, in new scopes and as retrofits to those already in the field. You'll see 18 reticle designs on the CS

pages of Leupold's current catalog. "We can also install a long-range reticle matched to your specific load," Alan said. "You send us the factory load, or the ballistic coefficient and starting velocity of your pet handload, and we'll build a reticle with marks that indicate dead-on hold to 500 yards, at 100-yard increments." I've used those scopes – by Leupold and by GreyBull, which fits Leupold scopes with its own 1/3-minute elevation dials. For shooting at distant targets, such reticles boost your odds for first-round hits.

Cosmetically, the CS can put benchrest rifles and Indy cars to shame. From 24k gold plating of Leupold's emblem, to brilliant colors – even multiple-color schemes – and the imprinting of names and illustration, a custom scope affords you the chance to make the tube uniquely yours.

Are there limits as to what's available? Sure. "Illuminated reticles, for example, can normally be installed only in scopes already configured for illuminated reticles," said Alan. And optically, Leupold must hew to the constraints already imposed on design teams at every scope company.

Alan pointed out that some scopes and features draw enough interest to keep them on a CS list of recommended items. "Though they're not so popular as to justify standard production runs. We call them CS exclusive scopes. It does not include distributor specials like those Zombie cosmetics that flooded us with orders at the 2012 SHOT show."

Here's that list of exclusives:

1.5-4x Scout

1.25-4x VX-R Scout

3-9×40 AO

3.5-10×40 AO

3x

6×33 Compact

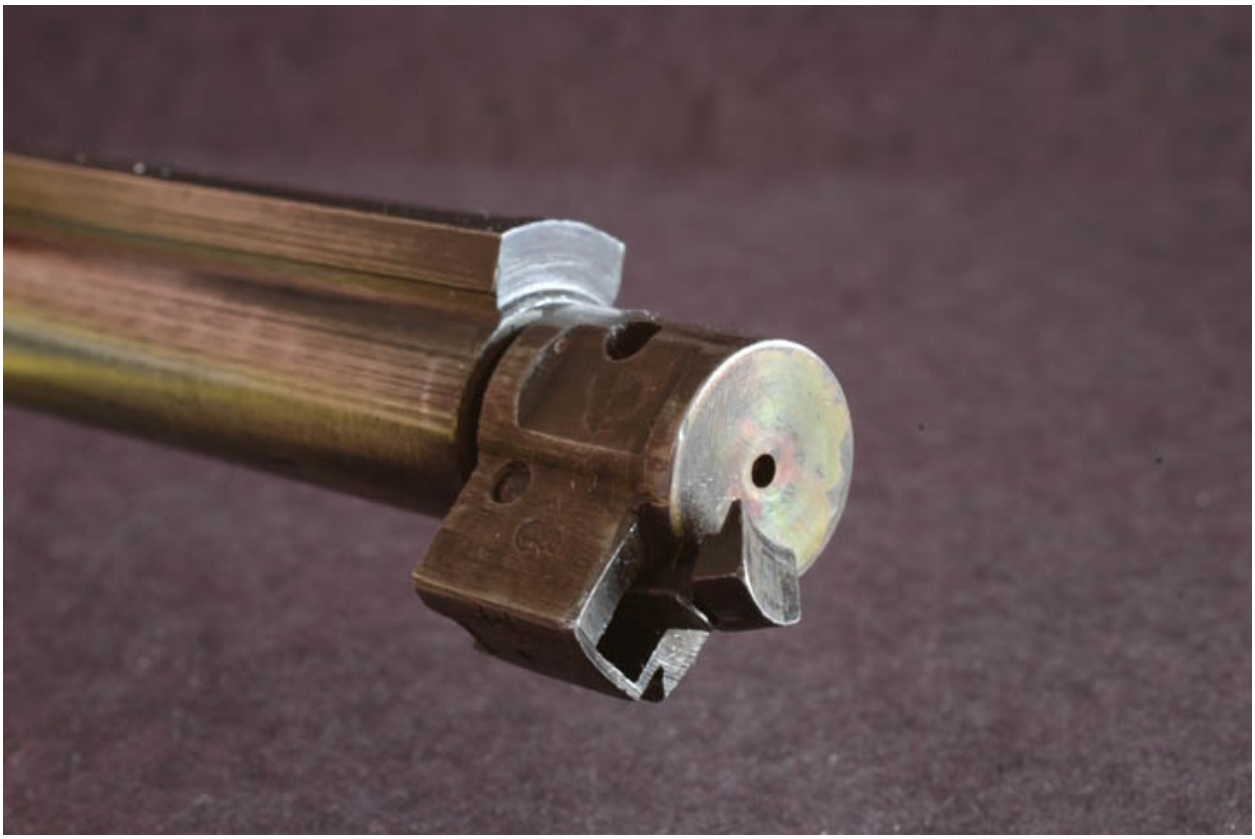
8×40 AO

8×40 Target

This article originally appeared June 20, 2012 on GunDigest.com.

Chapter 12

How Handloading Affects Headspace



Britain's ageless Short Magazine Lee Enfield was given a replaceable bolt head, to adjust headspacing.

Headspace, measured from the bolt face to the cartridge stop in the chamber, is set during barrel chambering and installation.

The barrel nut on Savage 110 rifles is a clever way to make headspacing easier and cheaper. British SMLE rifles have replaceable bolt heads that varied slightly in length, for a quick field fix of improper headspace.

But as a handloader, you control effective headspace, because in sizing cases, you determine the relationship of cartridge to chamber. Even when the

barrel is properly reamed and expertly installed, errors in case preparation and loading can introduce headspace problems.

Once I was sizing cases for a wildcat 6mm cartridge, the .240 Hawk. I set the die to full-length size, to ensure the cartridges would easily fit the chamber. My first shot blew gas from all crevices of the stout Remington 700 action.

The case showed a circumferential crack forward of the belt. Because the loads were not stiff, and because the bolt lift did not indicate high pressure, I fired another round. Same result. I compared sized cases with the fired cases. The sized .240 hulls were shorter by nearly .1 inch.

So I unscrewed the sizing die until it hung 1/8 inch shy of contacting the shell-holder. The first case sized at that setting wouldn't chamber. Lowering the die incrementally and trying the case at each setting, I finally closed the bolt.

Excess headspace causes hulls to stretch unduly ahead of the web. A split, and spilled gas, can result.

At this point, the die and shell-holder were .1 inch apart. Unlike most commercial dies, this one reduced case length excessively when flush with the shell-holder. It made the case .1 shorter than the chamber.

When I fired those first rounds, the striker drove the case forward .1 inch, and the rear of the case backed up .1 inch against the bolt, pulling the brass apart just ahead of the web.

Full-length sizing compresses a cartridge case; firing stretches it. Think about what happens after repeated bending of the tab on a soda can. To prolong case life, neck-size only, so the brass moves little upon firing.

Because a cooling hull shrinks after firing (otherwise it wouldn't easily extract), there's no need to further reduce its dimensions unless you plan to use the ammunition in another rifle that has a slightly smaller chamber.

The only other reason to full-length size (or to use small-base dies that squeeze cases down even further) is to feed autoloading or lever-or slide-action rifles with little camming power. Some hunters full-length size the cases they'll use on a hunt, to ensure easy chambering.

Neck sizing is a particularly good practice with belted cases, because chambers for these hulls are often cut generously up front. The critical dimension, after all, is the distance from bolt face to belt face – .220 to .224, "go" to "no go." If you full-length-size belted magnums, you may be shortening the head-to-shoulder span considerably each time—which means the case stretches a lot at each firing. Eventually (sometimes soon), you'll notice a white ring forming around the case just ahead of the belt.

If you insert a straightened paper clip with a small "L" bend at the end and feel around the inside of the case, you may detect a slight indentation forward of the web. The white ring signals a thinning of the case there and the case will separate if you keep full-length sizing the case.

Rechambering rifles to Improved, or sharp-shouldered, cartridges should not change headspace measurement. The reduced body taper and steeper

shoulder angle provide greater case capacity, but the datum point on an altered shoulder should remain the original distance from the bolt face.

"Improved" cartridges are blown-out versions of rimmed or rimless rounds, here the .30-06. The .30-06 Improved (left) has the same headspace measure. Standard ammo can be used in an Improved chamber.

That's why you can fire factory ammunition in an Improved chamber safely. True wildcats that require case forming in dies must sometimes be given a false shoulder to serve as the chamber stop before firing full-power loads.

Headspace is a length measurement. It has nothing to do with diameter. After long use, reamers cut slightly smaller chambers than when new. New reamers or those used aggressively can bore oversize chambers. Headspace can change over time. With each firing of your centerfire rifle, some compression of the locking lugs and lug seats occurs.

The elasticity of the steel keeps headspace essentially the same. But many firings with heavy loads can drain that elasticity and cause a permanent increase in headspace.

A rifle with hard lugs and soft seats and generous headspace can eventually develop so much headspace that a field gauge can be chambered. At this point the rifle is unsafe.

This article originally appeared Aug. 6, 2012 on GunDigest.com.

Chapter 13

Handloads: Will Your Gun Blow Up?

Wayne's Springfield sporter in .30-06 Improved has a 7-digit serial number, higher than the 800,000 that marked the end of low-carbon, case-hardened receivers in 1917.

Firearms come apart when gas pressures from burning powder can't leave soon enough. Time matters. Pressures can't build to dangerous levels if you don't give them time.

On the other hand, you must give pressures time to build to useful levels. The bullet is an obstruction. Its resistance (friction and mass), plus barrel length and the relationship of bore to case capacity determine the appropriate powder and charge. A charge of fast-burning Bullseye powder behind a lightweight bullet in a .45 ACP pistol generates a sharp, quick thrust. It must, because that short bullet is easily dislodged.

As it races through the short bore, a huge space opens instantly behind it. The powder has little time to work before its energy dissipates. Think of a ping-pong paddle in action.

A rifle powder such as 4350 in a bottleneck case like a .270 generates pressure more slowly as it burns. The bore is small, relative to case capacity, and the bullet long. An instant burst of energy from Bullseye wouldn't give the sustained push needed to overcome bore friction and accelerate the long, slim .270 bullet through a long barrel.

Cowboy Action ammo loaded to mild pressure helps safeguard this pristine, valuable Winchester 53.

Heavier charges of fast powder would lift pressures to dangerous levels. Bore space behind the bullet wouldn't increase fast enough to relieve it. Think of that ping pong paddle meeting a baseball. The paddle (or your wrist) would yield before the momentum of the incoming ball could be reversed.

Like handgun ammunition, shotshells use faster powders than those in bottleneck rifle hulls. The heavier the shot load, the slower the powder. Short pressure curves don't mate well with slow acceleration against high resistance.

Also, shotgun barrels and/or actions weren't designed to bottle stiff pressures. Big bores and straight cases flush pressure out fast.

Rifles of modern steel seldom come apart. Acceptable breech pressures of smokeless centerfire rounds as determined by SAAMI (Sporting Arms and Ammunition Manufacturers Institute) run from around 42,000 psi for the .30-30 to over 60,000 psi for high-velocity magnums.

Several bolt rifles safely digest proof or "blue pill" loads of more than 100,000 psi. Famously, Springfield 1903 receivers to serial number 800,000 (in 1917) were of case-hardened, low-carbon steel, not as strong as subsequent double-heat-treated receivers. These acceded to even stronger nickel-steel receivers at serial number 1,275,767 (in 1927).

Proper charges of proper powders help keep your rifle intact. But careless mixing of cartridges can make even safe loads hazardous. Once a pal inadvertently loaded a .308 round in his .270. The .308 cartridge is shorter, so the bolt closed before the bullet met the smaller neck of the .270 chamber.

Powders must match not only cartridges but bullet weights. Choose carefully; handload conservatively.

When he fired, pressures vaulted as the .308 bullet squirted through the .277 bore. The bolt froze shut. Gas from the ruptured case blew the extractor off and jetted through the magazine well, splitting the stock into three pieces. Fortunately, the Mauser lugs did not fail, and my friend was wearing glasses.

Another way to blow a rifle is to not use any powder at all. Once, having heard only the hammer fall as I triggered a borrowed rifle, I opened the action and ejected a fired case. “Must have forgotten to cycle the lever,” thought I, and chambered another round. But just before I fired, another possibility came to mind. Action open, I looked into the bore. Dark.

The rifle’s owner had failed to add powder to that first case. The primer had driven the bullet inches into the bore. Had I launched another 200-grain softpoint, pressure would have spiked as it collided with the stuck bullet. The Model 71 Winchester would almost certainly have been ruined, with injuries likely.

Don’t use someone else’s handloads! Pull the bullets; use the components.

S&W’s powerful .460 generates rifle-like pressures. Don’t stray from recommended charge weights!

You've read caveats about firing smokeless loads in Damascus shotgun barrels – those made by wrapping heated bars around a bore mandrel. The rule makes sense, as does the use of black-powder or "smokeless for black" (not full-power smokeless) loads in old double rifles. In truth, some early rifles and Damascus shotguns thrive on modern ammo.

I have it on good report that the actions and barrel thickness of Parker shotguns dating to the early 20th century are such that Parker proofed to higher pressures than generated by modern target loads, even some duck loads!

Still, barrel steels of a century ago don't match ours today. Breeching that has become loose, or weak cases or oversize or damaged chambers add risk. When in doubt, have the gun examined by people with appropriate equipment and expertise, or stick to mild loads.

Hewing to conservative loads in old guns, and taking care to use the right powders and ammo can keep stock and steel in one functional piece, and you, too.

This article originally appeared Aug. 24, 2012 on GunDigest.com.

Chapter 14

The Best Rifles Are .375s!

Designed for cordite powder, the .375 has a sleek, tapered case that feeds easily. A wide variety of softpoints and solids makes it truly versatile.

A hundred years ago, the English gun-making firm of Holland and Holland introduced the .375 Belted Rimless Nitro Express. It arrived Stateside in 1925, when Western Cartridge Company began loading it. As the .375 H&H Magnum, it spawned the .300 H&H Magnum. Around 1926, up-scale New York gun-builder Griffin & Howe began barreling Magnum Mausers to .375.

In 1937 it became a charter chambering in Winchester's new Model 70. Remington offered the .375 H&H in its 725 Kodiak (though fewer than 100 were

built, all in 1961). Actions for the .375 must accommodate its 3.60-inch loaded length. Cases measure 2.85 inches, base to mouth. A rimmed form of the .375, for double rifles, also appeared in 1912: the .375 Flanged Magnum Nitro Express. But the belted round works fine in hinged-breech mechanisms. Steeply tapered, with a shoulder angle of less than 13 degrees, .375 rounds slip eagerly into a double's open breech, and feed silkily in bolt rifles.

In his book, "African Rifles and Cartridges," John Taylor praises the .375 H&H: "I've had five of these rifles … and have fired more than 5,000 rounds of .375 Magnum ammunition at game…. One [rifle] accounted for more than 100 elephant and some 411 buffalo, besides rhino, lions … Although my formula gives this rifle a Knock-Out value of 40 points, I must regretfully admit that does not really do full justice to it."

One Woodleigh solid from Wayne's Mauser at 16 yards dropped this elephant. The bullet entered between the eyes, penetrated to a hip.

Taylor recalled a buffalo he'd shot with a 300-grain solid from his .375 double. "The bull dropped to the shot but in an instant was up again … I gave

him the left barrel fairly in the center of his great chest…. He crashed on his nose [and] keeled over — stone dead."

With .375s I've downed buffalo and elephant. Woodleigh solids, loaded in Norma ammunition, drive deep. At 350 grains, they carry more weight and length than standard 300-grain bullets. The stout Trophy Bonded bullets (Federal) and Swift A-Frames are my pick for softpoints.

In full-throttle loads, they bring two tons of energy to 50 yards. Still, the .375 can be chambered in a rifle as lively as a .30-06. Most hunters can point such a rifle more deftly than they can a heavier if shorter, double. And they can fire it without fear of turning their cheek or shoulder the color of old cheese. Part of the reason the .375 is so popular for dangerous game is that it can be fired accurately by people of average build and shooting experience — in rifles of modest weight.

Quick handling and high magazine capacity make first hits faster, and put more bullets into crippled animals than might be possible with ponderous big-bore rifles. A couple of years ago, I dashed around a bush to the cry of a tracker who'd come suddenly upon the leopard we'd been trailing. My .375 — a Montana Rifles lightweight — came up like a shotgun and all but fired itself. The cat rocketed into the air with broken shoulders. It died as it hit the ground.

My favorite .375s? Certainly that Montana, which has also taken buffalo and eland and a big giraffe — which weighed almost twice as much as a buff! An old Model 70 with Redfield receiver sight downed my first buffalo and still ranks high. Sako's handsome Kokiak has a nose for the target; its laminated stock is among the most comfortable I've used. Remington briefly marketed a Mauser in .375, and I snapped one up. It's a classic, with features — a positive extractor, dead-certain feeding — that made early .375s so effective.

Wayne used this BRNO rifle in .375 for buffalo n Australia. He fired Norma Africa PH ammo featuring Woodleigh bullets.

For decades, the .375 H&H brooked no rivals. In the 1940s Roy Weatherby came up with his own .375 Magnum on the same case, but blown out, with a radiused shoulder. Despite a velocity edge of 200 fps, it couldn't compete with the Holland round. (Recently it has returned to the Weatherby stable). A few years ago, Hornady trotted out the .375 Ruger. Developed to work in .30-06-length actions, it has roughly 10 percent more capacity than the .375 H&H Magnum, thanks to a wider body with little taper. Its .532 head diameter is the same as that of the .375 H&H; but the .375 Ruger is rimless. It pushes bullets 5 percent faster, from a hull .27 inch shorter.

Still, in every game field worldwide, you'll find cartridges for your .375 H&H rifle. It may be another century before another .375 can make such a claim!

Chapter 15

Big Game Hunting Bullets that Disintegrate?

Dynamic Research Technologies hunting bullets are designed to disintegrate. This 79-grain tungsten bullet has turned to dust in gelatin.

Percentage of retained weight may appear the reigning measure of expanding bullet performance in game, but the last deer I've shot fell to thin-jacketed hunting bullets of ordinary construction. And in Missouri, Dynamic Research Technologies (DRT) is making big game hunting bullets designed to, well, disintegrate into tiny particles.

"We've found they kill better than deep-driving softpoints," says Dustin Worrell, who runs DRT. "In fact, we've used them on nilgai."

Hunting the big, tenacious Indian antelope in Texas, the DRT crew clobbered 11 with 79-grain spitzers from their .223s. Locals, who recommend heavy bullets from .30 magnums, were astonished.

The DRT hunting bullets that put those nilgai on the skids had tungsten cores, Worrell concedes.

He said, “But the tungsten is sintered. It doesn’t stay in one piece. It turns to dust during penetration, just like bullets we make with cores of copper and tin alloys. The tungsten adds weight to bullets of ordinary dimensions. Its particles are heavier too, so drive a bit deeper. But we don’t expect exits. By the time a DRT bullet gets halfway through vitals, it’s pretty much the consistency of powder!”

Though costly “controlled expansion” bullets nab headlines, traditional designs like this are still deadly.

Such bullets date to the 1990s, when Harold Beal explored frangible metal cores at the Oak Ridge National Laboratory. His goal: deadlier .45 ACP service ammunition.

In 2005, John and Dustin developed machinery to make hunting bullets using Beal’s patents under license. Dustin and company have focused recently on muzzleloading bullets, which they test on deer on their Missouri whitetail ranch.

His records show deer don’t run as far when struck with DRT hunting bullets as when hit with polymer-tipped hollowpoints. The 170-grain 45-caliber DRT fits an ordinary sabot. A thin (.030) tin cap tops the sintered core at the base of a big nose cavity. Accuracy from a rifle I benched averaged an impressive 2 minutes of angle.

We joined a hunting party headed to the woods with T/C muzzleloading rifles. In three days, we took nine deer with the DRT hunting bullets. I killed a “management buck” and a doe. Hit in the forward ribs, the buck dashed about 30 yards and piled up, dead in mid-stride. The doe lasted a couple of jumps.

“These bullets needn’t plow through the lungs, or even reach them,” said Dustin, as he autopsied a deer on the meat-pole one evening. “We’ve killed deer with .223 bullets that didn’t enter the chest. That burst of energy as the bullet disintegrates imparts shock that ruptures blood vessels in the liver and other vital organs.”

The high velocity of the lightweight .45 DRT bullet no doubt heightens that effect. Have thin-jacketed lead-core bullets of traditional design been too quickly abandoned for hunting bullets that weigh almost as much expended as at the muzzle? Could be.

Norma's new Kalahari loads use lead-free bullets designed for quick upset on plains game, deer.

One of the deadliest deer hunting bullets I've ever used is the 165-grain 30-caliber Sierra hollowpoint. It opens violently, but blasts through scapulas.

In elk, it's better slipped through the ribs than driven to the point of the shoulder. Ditto for softnose classics like Winchester's Power Point – an overlooked bullet that's been around since I started hunting 45 years ago. I've taken elk with it, handily.

The same goes for Remington's Core-Lokt. And Hornady and Speer softpoints that get less press than so-called "controlled expansion" bullets.

Honestly, all bullets are designed to expand predictably – that is, in a controlled manner. With materials and engineering, hunting bullet makers manipulate upset. Penetration comes at the expense of wound channel diameter and fast energy release.

Some hunters like exit wounds; I prefer hunting bullets than drives through vitals but balls up just under the off-side hide. For heavy game, I favor softpoints with the moxie to splinter the near shoulder but carry on through the lungs.

I don’t care much how hunting bullets look when I pluck them from an animal, because I’ll not use them again. I do care about the damage inside. Weight retention seems to me over-rated.

The famous Nosler Partition typically loses 40 percent of its weight as the nose breaks apart in tough going. But that shattered nose shreds the vitals as the bullet’s protected heel drives on, commonly exiting.

As the DRT people have found, violence between the ribs is the lethal agent.

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Chapter 16

The .22, Just Shy of Magic

Among svelte .22 rimfire rifles is Browning's T-Bolt, here in .22 WMR. A 40-grain bullet at 2,000 fps.

Far from the most powerful, the .22 Long Rifle is arguably the most useful cartridge of all time.

It dates to 1857, when Horace Smith and Daniel Wesson came up with a rimfire round while working on a lever-action rifle. That primitive Volcanic rifle would evolve into the Henry, the foundation of Winchester's 19th century dynasty.

Meanwhile, Smith and Wesson would turn to another firearms venture. Their rimfire cartridge endured 30 years of development. Its progeny, the .22 Long Rifle, arrived in 1887, courtesy the J. Stevens Arms & Tool Company. A

black-powder cartridge with 5 grains driving a 40-grain bullet, it evolved later to take smokeless powder in a case with a crimp clutching the heeled bullet.

Remington claimed the first modern high-speed load in 1930. Current .22 ammo includes friskier offerings, but they're all sinfully pleasant to shoot. Feeding a .22 costs so much less than stoking a centerfire; you can almost keep Junior in college with the difference.

My love affair with .22 started on a fence rail, where I shot barn rats with a Remington 121 and .22 Shorts. Squinting into that J4 Weaver was like looking through dishwater.

I trained with iron sights on a Remington 40X .22 match rifle, then sold my soul for an Anschutz 1413 to join a University smallbore team. Eley Match ammunition nipped one hole at 50 meters. I won a state prone title, and then foolishly sold that rifle.

From left: .22 Long Rifle, .22 WMR, .17 HMR, .17 Mach 2. The popular .22 Long Rifle dates to 1887.

The scope, a Redfield 3200, sat next on a McMillan-barreled Remington 37. It snared a second state title. By the time targets got too fuzzy in iron-sight

stages, hunting-weight .22s had filled a gun rack in my office.

Cooper, Kimber and Weatherby bolt guns joined the Marlin 39s, an autoloading T/C and a Remington 121 that's as fetching as the rat rifle of my youth. A Ruger and a Savage in .22 WMR, and a Cooper in .17 HMR offer more reach. The Cooper is obscenely accurate.

I should have kept the Browning BLR and Winchester 9422 that left for more responsible owners – and the 52 Winchester with 10x Fecker my wife used to thin ground squirrels near an Oregon farmstead.

I'm obliged to keep the Winchester 75 Sporter, an inheritance on Alice's side. "It's mine," she says.

It's fashionable in some circles to scoff at the .22 Long Rifle, as if it were OK for kids but not for real riflemen. Well, some real accomplished shooters have used .22s.

Phoebe Ann Moses was one. Born in a log cabin in Darke County, Ohio, she showed early talent with rifles when she started killing quail on the wing with a .22.

At a local turkey shoot she beat not just the local boys, but visiting sharpshooter Frank Butler. She was 15. Frank married her within the year.

She joined his traveling show under the stage name Annie Oakley, shooting tossed glass balls. Petite at 100 pounds, Annie had the endurance to hit 943 of 1,000. She'd cut one ragged hole in a playing card with 25 shots from a .22 rifle – in 25 seconds.

Once she shot a cigarette from the lips of a German crown prince. After he became Kaiser Wilhelm II and Europe entered the Great War, Annie allowed that with a flinch she might have altered world history.

Rimfire drills help you hit with deer rifles. Here Wayne pesters sodpoodles with Browning's BL-22.

Not long thereafter, a lanky Texan named Ad Topperwein began entertaining. He left audiences agape by shooting aerial targets as small as a steel washer. When the washer showed no reaction to a shot, Ad would turn to the crowd and deadpan that the bullet went through the hole.

Hecklers jeered – until Ad stuck a postage stamp over the washer, tossed it again and perforated the stamp with a .22 bullet. In 1894 he shattered 955 of 1,000 air-borne 2 ¼-inch disks.

Dissatisfied, he repeated, busting 987 and 989. It was said Ad could hit the bullet of a tossed .32-20 cartridge without tearing the case. In 1907 at San Antonio's fairgrounds, he uncrated 10 Winchester 1903 self-loading .22s, tens of thousands of rounds of ammo and as many wooden blocks.

He endured 120 hours of firing before calling a halt. He'd fired at 72,500 blocks and missed nine. His longest run of hits: 14,500 straight!

The .22 Short once common at booths on the "midways" of state fairs is about gone. Winchester's 1890 pump rifle, then a staple in shooting galleries,

has become collectible. The mild BB and CB (Bullet Breech and Conical Bullet) Cap cartridges peddled as pest ammo in those days have faded away, too.

The .22 Long, with a 29-grain Short bullet in a Long Rifle case, never caught on. But the Long Rifle steams ahead, as popular as ever. The best target loads can deliver half-minute accuracy. High-velocity hunting bullets give you 90-yard point-blank range with a 75-yard zero. Bullets strike about an inch high at 50 and 3 inches low at 100.

I once shot a crow at a paced 145 yards. It must have been the bird's day to die, as I was shooting a lightweight lever rifle with iron sights.

Sometimes a .22 is just shy of magic.

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Chapter 17

Big Game Rifles

What Happens Between Shot and Down

Gemsbok (or gemsbuck) rank among the toughest of plains game. The hide is elastic, and blood trails are often sparse.

Big game that drops instantly to a shot is cause for concern.

Bullets don't hurl animals to earth; an immediate collapse usually mean you've struck the spine. A severed spinal cord anchors the beast. If your bullet has also sent fragments through the chest or so shattered the forward spine as to deliver fatal shock, you won't have to fire again.

Without knowing that, you'd best cycle the bolt and ready yourself for another shot. Bullets that strike spinal processes – those short appendages on

vertebrae – also deliver a hammer-like blow. But the animal can recover, sometimes within seconds. Once it regains its feet, you'll likely not bag it unless another hit follows, pronto.

You can expect reaction to both bullet strikes and near misses. If the buck doesn't react instantly, you probably missed. A bullet arrives faster than you can get your scope back on target, and the reaction is involuntary. If you see the deer duck, and it runs with tail up, it is likely unscathed. A deer that stands as if puzzled by the blast and sonic crack is almost surely untouched. Sudden noise can be hard to place; animals often pause, to determine a safe exit.

Up close you'll seldom see the eruption of hair, dust or water, the flinch, the caving to the blow when your bullet lands. The violence of recoil will obscure all.

An offhand shot up close destroyed this bear's heart. It ran as if untouched – but only for 30 steps.

At distance, depending on light conditions, bullet velocity and your recovery time, you will. The sound of a strike follows reaction to the hit. A .270 bullet leaving at 3,000 fps averages about 2,700 fps over its first 300 yards. It

reaches a deer 300 yards away in a third of a second. The thud of impact takes a second ambling back. You'll hear the hit about 1 1/3 seconds after you fire.

The solid "thwuck" of a bullet through front ribs is welcome music. A sharp "whock" means you struck big bone; a sodden, splashy, hollow landing means a paunch hit.

Always assume a hit. Always reload quickly. Excepting offhand shots up close in timber, I stay in shooting position for at least 10 seconds after a shot. If game appears after the shot, I make sure it is the same animal before firing again.

Always check if you suspect a miss. First, flag your shooting spot and the place where the animal was when you fired (I carry ribbon for this purpose). Many deer are lost because hunters don't follow up intelligently after the shot. Blood may not appear on the trail for many yards, even if the damage is lethal. I've found dead deer and elk many yards from where they were hit and had to back-trail to see any blood. A bullet that doesn't pass through may cause lots of internal hemorrhage, only to have elastic hide slip over the entry hole during escape, impeding leaks.

Once, after calling a good shot at a deer in open woodland, I watched it gallop off at an even and deliberate pace. I followed the hoofprints but found no blood. Returning to the site of the hit, I got down on hands and knees, searching in circles. A tiny pink pellet with a single deer hair caught my eye. Lung.

Carefully, I worked my way along the trail again. This time I found a drop of blood. At a turn in the trail, I spied a track I'd missed before. The buck lay a few steps farther on.

This South Dakota mule deer ran off after the hit. But the hunter persevered, delivered a killing shot after trailing.

Game commonly makes an abrupt turn just before collapsing. A buck I hit too far back slipped into dense willows. I followed on hands and knees as the vegetation pressed in. There was no blood; it seemed as if the earth had swallowed this deer. Then I spotted a small gap to the side of what was now just a rabbit's path. I crawled through it – and onto the carcass of the buck.

Perseverance is an asset. You might also call it a requisite. When you fire at big game, you have the responsibility to follow up. Some years ago, guiding a mule deer hunter, I spied a buck across a draw.

My client decided to shoot. The deer ran immediately. "Aw, I probably missed," said the man, obviously not keen to cross the rugged draw and spend time on the deer's trail. I insisted, though, and presently we stood where the animal had. "See, no blood."

My companion wanted to start hunting again. I left him at the site and tracked the deer into timber, where I found it dead.

Lethal hits don’t always put game down immediately. In fact, most of the animals I’ve shot have moved before dropping. Regardless of the reaction, I always check and follow. As do all sportsmen.

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Chapter 18

Why Some Guns Have Soul and Others Do Not

Cooper centerfire rifles combine modern design with the soul of fine walnut and clean, traditional lines.

Opinions are like shopping bags: cheap and ubiquitous. Mine get about as much notice. Most recently, I've held forth on Chihuahuas, subsidized soybeans and motorists who drive 55 in the left lane. The soybean has kept its record reasonably clean, so I've managed one positive review.

Firearms have tripped me up. To report on them as tools is to ignore their soul. To admit that they have soul takes Darwinism to a new level. It also leaves some current guns with poor marks. It's no trick to make firearms that work. Brilliant 19th-century inventors did that. CAD drawings, CNC machines and

better steel can improve hardware, but they don't add or maintain soul – or even elemental "gunniness."

Before John Browning tired of sending designs to Winchester, he came up with some of the most fetching rifles ever, from the 1886 to the 1894. For decades after the Civil War, lever-actions proved as popular as the Homestead Act. Then came the Model 1895, a lever rifle for the government's powerful .30-40, .30-03 and .30-06 cartridges.

The author drilled this knot with a wood-stocked E.R. Shaw rifle. Barrels that float ignore shifting walnut.

I'm not a fan of the 1895. It does show the wonderful machining and finish common to firearms of its day. It does function reliably, and permits use of pointed bullets. But the 1895 is a cruel rifle. The stock comb is sharp and has lots of drop. It jabs you viciously in the chops. The sights don't line up for me. When I cycle the action, the lever pinches my fingers. All that shuffling steel

smacks of machinery by International Harvester. In the 95 you can also sense an incipient loss of soul.

Lest you think I'm heaping dung on a grave, I'd buy a minty 95 in a heartbeat, were it affordable.

Had anyone asked me, I'd have suggested that certain elements of the 95 (and its forebears) be carried forward. Soul resides in design, fit and walnut. Surely, the best hand-laid carbon-fiber stocks are clean to the point of elegance in profile, besides being strong, lightweight and waterproof. Still, the most attractive guns wear walnut.

Claims of wood bending to the whims of weather have over-stepped. Most hunters can't shoot well enough afield to tell if a stock is nudging the barrel or not. And wood is durable. That's why trees worth cutting for gun-stocks live longer than we will. Even straight-grained walnut has character to plumb, like the plain girl no one thought would become a CEO, or the "square" who later earned a PhD and a Guggenheim. Polymer has the eye appeal of tractor tires. Every black polymer stock is the same, as soul-less as it is colorless.

Kimber's Tactical rifle (top) has a wood stock painted black. Its Montana is synthetic-stocked. Elegant in profile, both look exactly like every other rifle of their type.

Had anyone asked me, I'd have suggested that synthetic stocks dress in color. Henry Ford had to buy lots of paint, and sticking to black gave him the leverage of volume. It also absolved him of having to decide which color the next customer would want. Eventually, even Henry conceded there were other profitable colors. Many gunmakers remain hung up on black. While hand-laid stocks do come in a variety of shades, and McMillan offers a giddy selection, the rule is still black. I'm tired of it.

Had anyone asked me, I'd have insisted that metal never "stand proud" of the stock; that rifle and shotgun stocks, fit more neatly than the doors on a tool shed. While CNC tooling has reduced variation in dimensions, tolerances in mating parts seem to have increased. Close fit shows care in manufacture. Once you could get it in a Winchester 94, millions of which traded for under $100.

Had anyone asked me, I'd have required any firm contemplating a commemorative floorplate to install a boxcar-size façade with said plating on the lawn of company headquarters. If it looks good there, it will probably pass muster on a floorplate. Otherwise, plain blued steel works fine. Triggers of bright pot metal might also accede to steel. Ditto plastic grip caps. Steel too costly? Omit floorplate and grip cap. If they've been stamped with decoration borrowed from lawn ornaments, it's best they leave anyway.

Even rusted, battered and taped, an early Winchester 94 has pick-me-up appeal. Original fit of wood to metal was tighter than on many more costly rifles now.

Had anyone asked me, I'd have scotched superfluous parts, starting with automatic and redundant safeties. A firearm's function is to fire. Multiple impediments make it as useless as a boat with holes.

Had anyone asked me, I'd have declared fixed throttles more useful than non-adjustable triggers. Pulls as heavy as a rifle's weight almost ensure the rifle

will move as the trigger breaks – just as double-action handgun pulls with the resistance of a bumper jack ruin accuracy.

While my opinions are mostly dismissed, gunmakers still sell serviceable products. Shooters still buy them, as 100 years ago they made peace with the mulish kick and finger-chomping lever of the 95.

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Chapter 19

The Nut on Fine Rifle Stocks

This slim grip on a Savage lightweight rifle is strong because it has perfect layout. Fiddle figure, too.

When I was a lad, you could buy a fancy American walnut stock blank for $25. I paid $7.50 for the plain but semi-inletted blank that went on my first deer rifle. Now even American walnut has become costly.

Black polymer is taking over. The problem with walnut is that you can't manufacture it. You have to grow it, and growing walnut takes a lot longer than growing tomatoes. We're inletting wood from trees that may have been around before rubber tires, before metallic cartridges, even before the Declaration of Independence. Don't figure on cutting gunstocks from trees you're planting now.

In a cruel twist of circumstance, the people who discovered walnut had no guns to put it on. That was back in the 13th century, when Marco Polo allegedly brought walnuts from their native Persia to Italy.

Nuts and seedlings eventually found their way to England, then to France and other parts of Europe. The scientific name for the species is *Juglans regia*, or "royal walnut." Common names denote location, not genetic differences. English walnut is *J. regia*; so is French. The tree eventually wound up in California, to be adopted as "California English."

Typically, California English wood grown from nuts has a tawny background with black streaking and less "marblecake" than England's walnut. Classic French is often red or orange. Circassian walnut – named after a region on the Black sea – seems to run heavy to black.

"These days the best *regia* walnut comes from Turkey and Morocco," the late Don Allen told me before his untimely death. Don knew a great deal about walnut. He searched the world over for gunstock blanks to use at his Dakota Arms Company. Those rifles still wear gorgeous walnut.

Cooper rifle stocks wear some fine walnut, selected from its ample store of carefully selected blanks.

Claro walnut, *J. hindsii*, was discovered around 1840, in California. Decidedly red, and with more open grain than English walnut, Claro was crossed with English to produce Bastogne. Nuts from this tree are infertile, but fast growth and dense grain makes Bastogne a favorite of stockmakers. It checkers more cleanly than Claro and withstands heavy recoil.

Sadly, this walnut is in short supply and diminishing fast under unrelenting demand. As with *J. regia*, the best Bastogne comes from trees at least 150 years old.

American or black walnut, *J. nigra*, has been the mainstay of our firearms industry since the first “Kentucky” rifles were forged in Pennsylvania. Typically, it’s an open-pored wood, warm brown in color, with just enough black to justify the name. It can be as plain as a power pole or richly patterned.

Quarter-sawn walnut has the “striping” common to many gunstocks; the saw runs across growth rings. Plane-sawed walnut shows wide color bands because the saw runs tangent to growth rings. Either cut can yield a sturdy, handsome stock, but quarter-sawn walnut is most in demand.

The warm glow of Claro walnut makes Winchester's M70 O'Connor Tribute Rifle fetching indeed.

Walnut must be dried before it is worked. But if the water leaves too fast, the wood surface can crack and check and eventually crust, inhibiting movement of "bound" water from the core. Structural harm may result. A kiln helps throttle the release of free water.

According to Don Allen, drying damage occurs most often in the first weeks after cutting. Moisture content will then stabilize at about 20 percent, after which time the blank can be air-dried or kiln-dried without damage. When the stock no longer loses weight, it's dry enough to work. Stockmakers may turn the blank to profile then – and let it dry another six months before inletting.

Proper layout imparts strength to a rifle-stock. The grain on a quarter-sawn walnut blank should run roughly parallel with the top of the grip, when viewed from the side. The grip will then best withstand recoil, and the forend won't easily bend. Seen from the top, forend grain should parallel the bore.

Figure in the buttstock won’t affect accuracy, but knots and crotches that produce interesting patterns up front can twist the forend. Though wood can shift with changes in moisture, modern finishes can make it almost impervious. Both wood and polymer stocks react to changes in temperature.

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Chapter 20

Top Hill Country Rifles

The author fires an early Hill Country Rifles M70 in .270 WSM. All HCRs are pillar-and glass-bedded.

The Hill Country of Texas boasts a passel of dedicated shooters and seems like a good place to look for a new rifle. That was Matt Bettersworth's thinking when he set out to give Hill Country Rifles (HCR) a national face. I called him up to see how that face looked.

"Sure. I'll ship one. How about a .270 WSM?" he said to me. It was a new cartridge then, a perfect pick.

The stainless Model 70 arrived promptly. It had a pebbly sage finish and functional checkering. The fit of metal to stock showed the care you'd expect from a rifle in the half-minute club. That's right; Hill Country Rifles people demand precision. I can't recall if, 13 years ago, they guaranteed half-inch knots. They do now, with factory ammunition. Even walnut-stocked models must meet that bar.

The catch?

"There really isn't one," Matt tells me. "Our line has expanded since those early days, but we still hew to high standards. Three-shot groups with selected ammo must stay inside an inch at 100 yards for Dangerous Game Rifles and the affordable Harvester series, half that for everything else."

A Hill Country Rifles firearm on a Remington 700 action punched this tiny knot. Half-minute standard? No problem!

HCR’s toughest test falls to the Long Range Tactical (.338 Lapua) Rifle with a Defiance Machine action, a McMillan stock and a Schnieder barrel. The companion Tactical Rifle is also in the .5 club. It comes with Remington 700 or Stiller action, McMillan or PSW stock, Schnieder, Lilja or Hart stainless barrel. Chamberings are offered in .223 to .338 Ultra Mag. Badger Ordnance components. A Cerakote metal finish, rail-mounted scope from Nightforce, Schmidt & Bender or Swarovski finish these rifles.

OK. They’re not ideal for steep carries on the mountain, or for navigating lodgepoles. More traditional is the Long Range Hunter, with a decidedly sporting figure and just 7.5 pounds of heft. It marries a synthetic stock of field dimensions with match-quality metal components. The Compact Sporter wears a shorter, heavier barrel.

Straight-combed McMillan stocks give HCR’s Sheep Rifle and Field Stalker Rifle svelte profiles. Stiller actions and stainless Hart barrels ensure snug groups. Like the Compact Sporter, they wear Timney triggers. Weights range from 6.5 to 7.8 pounds, depending on barrel length and contour.

All these rifles feature glass and alloy pillar bedding, with floated barrels. Hill Country Rifles tunes the trigger, even laps the rings for installed scopes. Stocks wear Pachmayr Decelerator pads. Dangerous Game Rifles with Dakota 76 actions have NECG (New England Custom Gun) sights and barrel band, and Talley scope bases with stout 8-40 Torx screws.

The affordable Harvester line from Hill Country Rifles includes this Safari Rifle with NECG fittings. Sleek. Businesslike.

Most remarkable and, to my eye, most seductive, are Genesis and American Classic Rifles, both in walnut. Hill Country Rifles stockmaker Michael Ullman does wonders with the wood. The American Classic is truly custom-built.

“We take no more than three orders a year for those,” says Matt. They’re on Model 70 or Dakota 76 metal, while the Genesis is Stiller-based. Both must shoot half-minute. I can’t name any other walnut-stocked rifle anywhere that’s held to such a standard.

Price? Mostly, you get what you pay. At Hill Country Rifles, you’ll likely get more than you pay for. But finely built rifles can suck the pig on the dresser dry.

If Junior is moving back because at 25 he can’t land a job as recreation director on Microsoft’s campus, or Sis needs a ‘Vette for commuting to Burger King, you might consider HCR’s Harvester Rifles. Sporting and Tactical models boast Remington 700 metal; the Safari has Winchester 70 action and barrel. All wear McMillan stocks. Sunny Hill, Badger and NECG accoutrements, and HCR’s accurizing service, equip them for the field.

Accurizing, by the way, is available for any rifle in your rack. Hill Country Rifles gunsmiths check bedding and locking lug contact. They examine rifling with a bore-scope. Then, if appropriate, they glass-and pillar-bed the action, lap lugs and scope rings, re-crown the muzzle, adjust the trigger – and shoot the rifle until groups tape under an inch.

Hill Country Rifles’ Genesis, a walnut-stocked Stiller, may be the only wood-stocked rifle with 1/2-MOA guarantee!

“If the rifle won’t drill sub-minute groups, we won’t ask full price,” says Matt.

My introductory HCR sporter in .270 WSM, a basic Model 70, delivered nickel-size groups. The next rifle, a 700 in .270 Winchester, came with a group that measured .3. Actions cycled like silk, a sure sign of honing. Clean, slim lines and perfect balance put these rifles to cheek before I felt their heft. Triggers broke like tiny icicles. No, you won’t find many icicles in Texas. But it’s a good place to look for rifles.

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Chapter 21

The Remington Model 700 Turns 50

The Evolution of an American Classic

This modern 700 SPS is a Spartan version, but sleek, with that unmistakable profile. Accurate, too!

You may already have been reminded that this is the 50th anniversary year of Remington's Model 700 rifle. While its ancestry dates to the 19th century, the Remington 700 really emerged from the 721/722 series, rifles that appeared in 1948. Developed by Merle "Mike" Walker and Homer Young, the 721/722 descended from the Remington 720, which appeared in 1941 to replace the .30

Express (1926) and its parent, the short-lived 30S (1921), both on the design of the 1917 Enfield.

The Model 721 and short-action 722 were economically built, with receivers cut from cylindrical tubing. Recoil lugs were thick steel washers sandwiched between receiver face and barrel shoulder. The clip-ring extractor, self-contained trigger assembly and stamped bottom metal pared costs. The bolt head with twin locking lugs was brazed (as was the bolt handle) to the bolt body. A bolt shroud supported the case head – an extra measure of security in the event of case rupture. Remington's plunger ejector enabled it to keep "three rings of steel" around the case head.

The Remington 721 in .270 and .30-06 cost shooters $79.95; the 722 in .257 Roberts and .300 Savage cost $5 less. Beginning in 1949 the 721 chambered the .300 H&H Magnum for $89.95. In 1960, Remington offered the .280 in the 721, a year later the .264 Winchester Magnum. The 722 brought the .222 and .244 Remington to riflemen. The .308 made the roster in 1956, the .222 Remington Magnum and .243 in 1958 and 1959. High-grade A and B versions of both rifles were replaced in 1955 with ADL and BDL designations.

Hugely popular among hunters, the Remington 700 has been chambered for dozens of cartridges.

To my eye, there's a Spartan elegance to the 721/722, and it is preferable to the angular lines and tasteless detailing on some modern rifles. But the series was admittedly plain. A perky follow-up from Remington designers Wayne Leek and Charlie Campbell was the Model 725, introduced in 1958. It featured 721/722 receivers but with hinged floorplate, checkered walnut, adjustable open rear sight. During 1961 and 1962, Remington's Custom Shop built a Kodiak Model 725. Chambered in .375 and .458 Magnum, it had a 26-inch barrel with integral brake. Just 52 of these 9-pound rifles left the factory.

In 1962, Remington fielded a brand-new rifle. The Model 700 borrowed heavily from the 721/722 – in fact, the mechanism is the same. Early advertising focused on those three rings of steel (bolt shroud, chamber and receiver ring) supporting the cartridge head. A trim tang, a swept bolt with checkered knob and cast (not stamped) bottom metal distinguished the 700 from its forebears. So did a more appealing stock, its comb higher for scope use. Chasing accuracy, Mike

Walker gave the 700 super-fast lock time (3.2 milliseconds), tight bore and chamber tolerances and a short leade.

Initially, the Model 700 came in two action lengths and two grades. Barrels wore iron sights. The ADL in .222, .222 Magnum, .243, 6mm, .270, .280, .308 and .30-06 retailed for $114.95. It had a blind magazine and pressed, point-pattern “checkering.” The BDL featured white-line spacers at buttplate, grip cap and forend tip, fleur-de-lis checkering for a price of $139.95. Remington also listed magnum versions of the new rifle: $129.95 for the ADL, $154.95 for the BDL. A special-order, safari-style 700, with braked 26-inch barrel in .375 or .458 Magnum, came from leftover 725 Kodiak stock. It was identically priced.

The 7mm Magnum round helped the 700 succeed. These loads shot best in Wayne's Commemorative.

The Remington 700 got a big lift from the concurrent introduction of the 7mm Magnum cartridge. The only other magnum slated for first-year production was, ironically, Winchester's similar but less ably presented .264. I'm told early magnum barrels actually taped at 23 ½ inches; by 1965 they were truly 24

inches, as advertised. The 20-inch barrels standard for the .243, 6mm, .270, .280, .308 and .30-06 were replaced by 22-inch tubes in 1964.

Five years later, the Remington 700 got its first facelift: a longer bolt shroud, jeweled bolt, restyled stock and machine-cut checkering.

By the mid 1970s, Remington had replaced the satin stock finish with tough RKW gloss. Remington first listed a left-bolt, left-stock 700 in 1973, in .270, .30-06 and 7mm Magnum. By then the Varmint Special had appeared, with heavy barrel sans sights. It chambered the .22-250 and, later, the .25-06—wildcat cartridges adopted by Remington in 1965 and 1969.

Beginning in 1966, Remington built M700s for military and police forces. Custom shop foreman Paul Gogol came up with a sniper rifle on a 40X action. Substituting the 700 mechanism, the company delivered 995 of these M-40 sniper rifles for service in Vietnam.

Models 721/722 and early 700 rifles had a side-switch thumb safety that arrested bolt and trigger. For hunters pushing through cover, a secured bolt handle is an asset. But a few accidental discharges as shooters unloaded rifles prompted a company recall. Remington's gunsmiths removed the bolt-locking mechanism on returned rifles. All 700s manufactured since can be unloaded with the trigger blocked.

For most of its life, the 700 trigger could be adjusted for weight of pull (lower front screw), sear engagement (rear screw) and over-travel (upper front screw). In 2005, the X Mark Pro trigger, with a fixed 3 ½-pound pull, replaced it. Four years later a pull adjustment was added, range: 2 ½ to 4 ½ pounds.

The 50th-year M700 Commemorative rifle closely resembles the first 700 BDL 7mm Magnum, 1962.

The Remington Model 700 has been bored to nearly every centerfire round practical in a bolt action. Barrels that were once hot-hammer-forged now featured cold-hammered rifling. Early stainless barrels in magnum 700s were plated with copper, and then tin, which took a blued finish. In 1967 Remington changed to chrome-moly steel for every 700 barrel. Stainless steel later returned, but not blued.

Remington has added many versions of the 700 since my first hunts with the rifle. I particularly like my 5 ½-pound 700ti with titanium receiver (2001) and the Classic series (1978) – also the Sendero (1994).

Remington has a commemorative, closely matching the original 7mm Magnum – even to the white stock spacers and "reverse" *fleur-de-lis* checkering. This 700 wears better-than-average walnut.

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